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CLIMAS Ranching Case Study: Year 1

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CLIMAS RANCHING CASE STUDY: YEAR 1

Julie Conley, Hallie Eakin, Thomas E. Sheridan, and Diana Hadley

Introduction

The arid climate of Arizona exhibits a wide range of both spatial and temporal variability in temperature and precipitation. Spatial variability is enhanced by dramatic elevational gradients ranging from 68 to 12,630 feet. The resulting climatic gradient creates a number of distinct life zones or broad plant communities. These range from Desert Scrub and Desert Grassland to Pinyon-Juniper and Oak Woodlands, continuing all the way up to Mixed Conifer Forest (McClaran and Brady 1994:208). Although these communities are relatively well adapted to the life zones they inhabit, the ecology is not insensitive to fluctuations in precipitation and temperature. Yellowing oaks in the lower elevations of Southeastern Arizona s Sky Islands this year are testament to the stress that plants can undergo during drought periods.

While the State s native flora has evolved some resilience to periodic extreme events or sequences of dry and wet years, the human systems — namely the farms and ranches of Arizona are newcomers to the region and are not as well adapted. Most of the state s cattle ranches rely solely on rain-fed range to support their herds. Drought conditions can result in significant declines in forage production and nutritional quality (Holecheck, 1998:155). Failure to respond to these changes with appropriate management can compound the effects of drought on already stressed vegetation resulting in poor range condition and animal performance. Complicating this climate-range-cattle relationship are many human factors that make the vulnerability of ranching to climatic variability so difficult to model. Land administration, household finances, regional and global commodity markets, public policy and political pressures are just a few of the concerns that make ranching one of the human activities in the state most sensitive to climatic variability and change.

This is perhaps nowhere better illustrated than through a review of the impacts of recent climatic events on the ranching sector. In the 1990s, Arizona experienced two severe droughts and at least as many years of high moisture conditions. Both the 1995/96 and the 1998/99 droughts have been related to the occurrence of La Nina -- the cool phase of the El Ni o/ Southern Oscillation ocean/atmospheric phenomenon. As a consequence of diminished winter rains during the 1995/96 drought period, many ranchers did not have enough forage to support their cattle. The persistence of the dry conditions for over a year s time forced some ranchers to resort to emergency coping strategies while some ranchers left the industry entirely. Although the implications of the current drought (1998/99) are not yet clear, it appears that many ranchers in the southeastern part of the state are once again having to adjust to very difficult circumstances.

The project discussed in this paper has three broad purposes: first, to compile a profile of Arizona s ranchers, with an emphasis on socioeconomic characteristics of ranchers in the southeastern portion of the state; second, to identify and understand the physical, social, and political-economic factors that make the livelihoods of ranchers vulnerable to climatic variability; and third, to determine whether or not ranchers can mitigate their vulnerability with improved access to information on climate. The project is in its initial stages and thus no conclusive data are available at this time. In this paper we will outline our assumptions in entering the project, our methodology, and some preliminary assessments from our work to date.

The Southwest Climate Assessment Case Study of Arizona ranchers

SW CLIMAS is one of several regional climate assessment projects whose purpose is to study the impact of weather and climate events on communities and economic sectors throughout the United States. Funded by the National Oceanic and Atmospheric Administration (NOAA) and established at the University of Arizona in 1998, the project s mission is to improve the ability of people and organizations within the Southwest to respond effectively to climatic events and changes. The project focuses on several different levels of community while integrating social and physical science perspectives. Through this project NOAA hopes to improve communication and understanding between the creators of climate information products and the potential users of those products.

This case study of the vulnerability of livestock operations to climatic variability is one of four case studies in the CLIMAS project that involve a more detailed analysis of stakeholder vulnerability and information needs. In this scoping paper, we draw on a pilot study conducted in 1996, initial interviews conducted in Benson, Arizona in 1999 and statistical information we have collected on ranching in Arizona. The first section describes our approach and methodology. In the remaining sections we present a socioeconomic picture of the livestock industry for the state, suggest some preliminary hypotheses about the vulnerability of ranchers to climatic variability, including some coping strategies ranchers employ, and provide our preliminary findings on the usefulness of climatic information in mitigating climatic risk for Arizona ranchers. This information will form the basis of research that will continue into the next year.

I. APPROACH AND METHODOLOGY

Theoretical approach to vulnerability

Vulnerability and adaptation to climatic variability and hazards are currently the subject of considerable academic research. In the global change literature, vulnerability to climatic variability and change typically starts with a judgment of the sensitivity of an economic sector, activity, or population, to changes in particular climatic parameters (usually precipitation and temperature, the parameters most easily modeled) (Parry 1998:91). Our initial assessment that ranching would be very sensitive to climatic variability was based on our knowledge of the sector s dependence on rainfed range.

While this assessment provided the basis for our focus on ranching as a vulnerable sector in Arizona, the concept of vulnerability is far more complex than the direct sensitivity of rangeland, and thus cattle, to changes in precipitation and temperature. Literature from Natural Hazards Research in geography, and much of the recent political-ecological research addressing food security and vulnerability in both geography and anthropology, have repeatedly shown that vulnerability is a complex function of interacting physical, biological, social, and political-economic factors (Palm 1990:117; Blaikie 1994:97; McCabe 1990:44; Hewitt 1983:116). While the direct sensitivity (or exposure) of a particular population or human system to change in the physical environment forms a central component of any vulnerability assessment, vulnerability is also a function of the ability of an individual, population or livelihood system to cope with the stress and rebound from its impact (Watts 1993:93; Downing 1996:94; Blaikie 1994:97).

For this reason in this study we are exploring not only the direct effects of climatic variability on ranching activities (e.g., physical factors affecting vulnerability), but also how rangeland policy and management, land administration, cattle and feed markets, trends in Arizona s demographics and political debates over grazing on public lands all contribute to the ability of ranchers to cope with the effects of drought, and their capacity to continue their ranching activities after the climatic event has passed. For the purposes of this study the most vulnerable ranchers are those that are unable to continue their ranching operations as a result of the confluence of socioeconomic, political, environmental and climatic stresses.

Methodology

To fully understand this vulnerability, we first required a robust profile of the ranching sector in Arizona. We collected statistical data from the United States Department of Agriculture (USDA) Agricultural Census, the USDA Economic Research Service, the Bureau of Land Management, the US Forest Service, the Arizona State Land Department and the Arizona Agricultural Statistics Service. Some of this data was available on the internet, while other data (particularly that which is administered by the land agencies) were collected from individuals and data files within each agency.

Given the importance of ranching in Arizona in terms of land use, culture, and history, one would expect that statistical data on ranching would be readily available. However, we found data on the sector to be dispersed among several state, federal, and private agencies. Moreover, the data are often of a contradictory nature. Land administration agencies such as the Bureau of Land Management, the Arizona State Land Department and the United States Forest Service all maintain data of various qualities on the grazing allotments and leases they administer. Over time the boundaries of these allotments can change, as can the administrating agency and the allotment tenants as a result of transactions such as land consolidation, trade, and new permit issuance. In some cases, the data files are updated regularly to reflect these changes, in other cases the agency data are inaccurate. We had no way of verifying the accuracy of the data other than consulting with individual leaseholders. No one agency collects and compiles all the available data on ranching allotments.

Not only are the data on land use problematic, but also the state lacks accurate data on the socioeconomic characteristics, demographics, size and activities of ranching operations. For example, the term ranch can imply several different things. The USDA agricultural census does not distinguish a ranching operation from a farm. From the USDA data, ranches could be defined by the quantity of revenue originating from livestock sales, or by classifying farms with a cattle inventory above an arbitrary threshold as a ranch. In popular understanding, the term ranch is used loosely to refer to both cattle operations and many new peri-urban subdivisions marketing a certain southwestern chic. A ranch could also imply a dude ranch that is not involved in cattle raising at all, but instead caters to tourists eager for a taste of the culture of the Wild West. In the discussion that follows, we will present different definitions of ranch from our data analysis.

For the purposes of our research, we only considered livestock operations with 100 head of cattle or more under the assumption that revenue from an operation with less than 100 head would not play a major role in household livelihood. To avoid confusion with the many definitions of the term ranch we will use the term livestock operation as a particular form of economic activity in which cattle production plays a significant role in household income. Although who should be called a rancher may be best left to those who wish to claim the title, we will refer to individuals engaged in livestock production as ranchers and their activity as ranching .

Despite these difficulties in definitions and data, we were able to accumulate some geo-spatial data along with socioeconomic statistics. Our ultimate objective is to create a spatial database of Arizona ranches that could be queried to answer contextual questions on vulnerability and to produce illustrative maps of the regions of our study. This geographic information system (GIS) would be particularly useful as a tool for the integration of bio-physical data (terrain, water sources, climatic characteristics and vegetation) with the socioeconomic and political characteristics that define ranching in the southwest. However, many of the problems associated with the socioeconomic data we were collecting are compounded in the development of a GIS. Although we collected data files containing allotment names, lessees, animal units (defined as a mother cow with calf, or equivalent), areas and boundaries from each land administration agency, the data are contradictory. The allotment boundaries of different agencies occasionally overlap and agency administration appears to conflict in some areas. We also have received conflicting information on total areas administered by each agency, and many of the attributes for particular allotments appear to be out of date. We are still attempting to reconcile conflicting data sources and hope to eventually use cartographic modeling techniques to develop a sampling strategy for our survey work.

The other components of the ranching study are qualitative in nature, consisting of in-depth, semi-structured interviews with ranchers and a written survey that is being mailed to a number of livestock operations in the southeastern corner of the state. Our pilot interviews were conducted in Cochise, Santa Cruz, and Pima counties using our survey as a guide for what inevitably became a conversation with our informants. The responses were reconstructed from notes taken during the interviews and recall. While the most recent interviews (1999) were all conducted in person, some of the interviews during the previous drought year (1996/97) were conducted over the phone.

A total of 17 ranchers were interviewed, 11 in the fall of 1996 and spring of 1997 and 6 more in February 1999. In 1996, the ranchers names were provided by a local livestock auction and through contacts from the University of Arizona s Institute of Arid Land Studies. In the 1999 names were selected in a ten-mile radius around Benson, Arizona from the Arizona State Land Department lessee files. We chose Benson in order to complement a parallel CLIMAS case-study which focused on the community of Benson s vulnerability to climatic variability.

Of the ranchers interviewed, one was Mexican American, one Native American and the remainder Anglo-Americans. In addition to ranchers, interviews with several managers of livestock auctions and range management experts contributed to the analysis. Our sample of ranchers was not characteristic of the sector profile. According to Arizona Agricultural Statistics most livestock operations in Arizona have between 1 and 49 head. The majority of operators we interviewed fell in the 100-499 head category. Two of the ranchers interviewed may have had less than 100 head, but were not willing to specify their herd size.

All but one of the ranches in the sample were family-run cow/calf operations (See **Type of Operations** below). One also bought up stocker cattle when pasture conditions were favorable, and at least two of the operations also retained part ownership of their cattle after putting them in feedlots either in state or out of state. The majority of those interviewed leased land from State of Arizona, the Bureau of Land Management, or the National Forest Service. Only one ranch of 22,000 acres was composed solely of deeded land. The ranches referred to by the respondents ranged from 5,000 acres to over 70,000 acres, with some ranchers owning additional ranches or pasture elsewhere. All of the ranchers interviewed were from southeastern part of the state. Future research will undoubtedly reveal different strategies and concerns among ranchers in other parts of the state because of differences in precipitation and temperature patterns. For example, ranchers at higher elevations may rely more upon winter rather than summer precipitation, while ranchers where precipitation is low and highly variable may run more seasonally responsive stocker operations and fewer cow/calf operations. Moreover, ranchers in areas of the state with less private and State land may be more concerned with changing federal regulations on public lands.

II. WHY RANCHING?: A PROFILE OF RANCHING IN ARIZONA

Although there are other sectors and economic activities on which climatic variability has a direct impact, ranching was identified by the CLIMAS project team as a sector that is not only sensitive to climatic variability, but that also has cultural, historical, ecological and political significance in the Southwest. With over two-thirds of the land area in Arizona classified and as rangeland, any change in the ability of ranchers to continue their range activities could have significant implications for the rate and direction of land use change, the balance of ecological and economic resource needs, the pace of urban development and trends in water consumption and conservation.

A case in point is the Sonoita Valley of southeastern Arizona, an area making the transition from ranching to real estate development. A study conducted by the Yale

School of Forestry and Environmental Studies concluded that a cow/calf animal unit consumes about 15 gallons of water on a hot, dry day. Because there are an estimated 1,600 cow/calf units in the Sonoita Valley, cattle consume about 27 acre-feet of water per year, well below the estimated average annual recharge of 3,980 acre-feet. That figure also includes water consumption by wildlife since pronghorn, deer, and javelina drink from the same water sources.

A single person in Sonoita, on the other hand, consumes about ten times as much water as a cow/calf unit. There are only two water-metered subdivisions in the area average 125-150 gallons per person per day---probably an underestimate of average per capita water use in the valley because these two subdivisions encourage water conservation. A conservative estimate of total water use at present is 337 acre-feet in Sonoita and 106 acre-feet in Elgin. Although those figures remain less than recharge now, future scenarios point to serious overdrafts. According to Yale hydrologists Robert Naeser and Anne St. John (1998:196), the safe yield development density in Senoita is one residence per 12.26 acres. In their words:

> Santa Cruz County zoning ordinances classify much of the developable acreage in Sonoita valley as General Rural (GR); minimum lot size of 4.13 acres (180,000 square feet). Under current zoning the Sonoita valley can accomodate 17,000 homes at build-out (8,200 in Area 1 and 8,800 in Area 2), assuming a total developable private acreage of approximately 70,400 acres. This level of density would result in annual groundwater withdrawals of 8,092 acre-ft/year (17,000 homes * 2.8 residents/home*0.17 acre-ft/person/year).

That figure is three times greater than the available surplus recharge. More than one home per 12 acres means that Sonoita would have to mine its groundwater. To insure safe-yield, the minimum size of a parcel would have to be tripled. But recent court decisions have ruled that Arizona counties have no right to downzone, i.e. to lower residential or commercial densities.

A case study of irrigated agriculture may be the subject of future CLIMAS work; the vulnerability of agricultural production to climatic variability and change has been, or is being, modeled in other regions (Easterling 1996:248; Rosenburg 1993:256). In contrast, there has been little research on the vulnerability of livestock operations to climatic risks. While groundwater pumping and air-conditioning buffer urban dwellers, tourists and irrigated agriculture from inter-annual climatic variability, ranchers depend directly on precipitation for the viability of their operations. Many do not have irrigated pasture, so rainfall is critical in maintaining adequate forage supply. Most ranchers also depend on precipitation as their main water source, capturing runoff in dirt stock tanks to make use of rangeland that would otherwise be inaccessible to their cattle.

A Brief History of Ranching in Arizona

Cattle ranching in Arizona dates back to the late 17th century when Jesuit missionary Padre Eusebio Francisco Kino gave small herds of cattle, horses, sheep, and goats to O odham Indians who agreed to live in mission communities. Spanish ranchers also began their own cattle operations in what is now the southern part of the state during the 1680s (Sheridan 1995:127). Spanish abuses provoked the O'odham to rebel in 1695,

driving Spanish ranchers south into Sonora, but settlers reoccupied the Upper Santa Cruz River valley in the 1720s and 1730s. Apache hostilities prevented them from expanding onto the grasslands of southeastern Arizona until the early 1800s, however. For most of the colonial period, livestock grazing was limited to the Upper and Middle Santa Cruz valleys and the Arivaca area.

During the final decades of Spain's rule, the Spanish Crown issued several land grants in the Santa Cruz valley and Arivaca. That process accelerated during the 1820s and early 1830s, when the new Mexican republic awarded more land grants to both individuals and groups of individuals. Ten of the grants were along the Santa Cruz River and its tributaries, but three straddled the San Pedro River to the east and one -- the San Bernardino -- encompassed the San Bernardino Valley in the southeastern corner of what is now Arizona.

Some historians of Arizona believed that those grants rivalled the great haciendas of Spanish and Mexican California. The idea that great herds of Mexican cattle grazed southern Arizona grasslands arose during the Mexican War, when U.S. troops encountered feral cattle as they passed through the region. John Russell Bartlett, who was in charge of the survey delineating the new boundary between the United States and Mexico, reported than 100,000 cattle grazed the San Bernardino grant alone. But as Sheridan (1995) points out, Barlett and other Anglo newcomers greatly overestimated the size of Mexican herds. Most land grants were occupied ten years or less before the Apaches killed or drove off the owners and their cowboys. All the feral cattle had disappeared by the early 1850s. In all likelihood, then, no more than 20-30,000 cattle grazed Arizona ranges at any one time during the Spanish and Mexican periods. The large numbers of feral cattle encountered by Bartlett and his contemporary clustered along streams or around springs because the centrifugal windmill was not invented until 1854 and not widely distributed on Western ranges until the 1870s. Cattle therefore could not distribute themselves evenly across the southern Arizona landscape. Extrapolating numbers from those encounters contributed to what Sheridan calls the "myth of the great herds."

Until the construction of two transcontinental railroads across Arizona in the early 1880s, the numbers of cattle and other livestock in early territorial Arizona did not increase dramatically. With the arrival of the railroads and the conquest of the Apaches, however, British and U.S. capital poured into the Western livestock industry, including Arizona. Arizona cattle numbers increased from perhaps 39,000 in 1870 to 1.5 million by the early 1890s. More than a million sheep also grazed Arizona ranges. During that decade, overstocking and widespread fuelwood cutting for mining coincided with a prolonged drought, devastating much of the landscape, including southeastern Arizona. In some areas, 50-75% of all cattle died.

The cattle boom and bust of the late 19th century was truly a tragedy of the commons on the open range. One response was the regulation of livestock numbers on public lands. Regulation was first imposed on the Forest Reserves, precursors of the National Forests. Forests were divided into grazing allotments leased to permittees, usually established ranchers. Forest personnel also set annual stocking rates on the allotments. With the passage of the Taylor Grazing Act in 1934, a similar system was established on federal lands controlled by the General Land Office, the precursor of the

Bureau of Land Management. Permittees on federal lands now had exclusive rights to utilize forage on their allotments but also had to abide with federal regulation of grazing on them.

With irrigation technology and dam construction in the 20th century, cotton and irrigated agriculture became significant sources of revenue for the state. The value of livestock production relative to vegetables, cotton, and other agricultural products has steadily declined over the last century. Nonetheless, ranching represents the most land-extensive industry in the state and an important sector of the rural economy.

Statistical Profile of the Ranching Sector

Cattle inventory and operations

Estimates of the numbers of Arizona cattle ranches vary depending upon how a ranch is defined. The Arizona Agriculture Statistics Service (AASS) labels all agricultural operations as "farms," including cattle ranches. In 1997, the AASS reported an inventory of approximately 790,000 cattle and calves and a total of 3,900 cattle operations (AASS 1998). In the last 30 years the cattle numbers in Arizona have declined by about 25% as ranching has assumed less importance in the state s economy. In just the last ten years, the number of cattle operations has dropped from a total of 4,600 in 1988 to just 3,900 today.

This probably is indicative of a trend towards an increase of small-scale operations (< 100 head) from 70% to 76% of the total number of operations, and a decrease in the number of mid-size operations (100-499 head) from 22% to 17% of the total number between 1992 and 1997 (AASS 1998). The increase in the number of small-scale operations may a shift in the industry from livestock raising as an economic activity, to hobby ranching, where the cattle operation is supported by income from other sources. The causes of this shift are of interest to this study, particularly if we can elucidate in our surveys and interviews the role climatic stress played in the decisions of mid-size (theoretically economically viable ranches) to down-size or go out of business.

Our interviews with agricultural extension agents and ranchers indicated that in general an operation needs at least 200 head to be viable as a primary source of income. As Figure 2 illustrates, the majority of livestock operations in Arizona in 1992 had less than 50 head of cattle while those operations with greater than 1000 head accounted for the majority of the cattle themselves. Only 18% of the state s cattle operations in 1992 had over 200 head. Although the data are not available for 1998, we do not expect that this pattern will have changed significantly. Although the socioeconomic data are not available to confirm our hypothesis, we argue that a relatively small proportion of operations in Arizona is supported solely from profits earned from range livestock production.

From 1992 USDA Census data, we estimated the number of cattle operations that could be defined as *commercial* (those farms deriving their principal income from ranching). By using the USDA Standard Industrial Classification definition of a beef cattle operation (a farm earning 50% or more of its income from beef cattle) we determined that 2337 of all "farms" could be classified as commercial livestock operations (USDA 1992). These figures suggest that livestock production is still relatively significant in terms of household income for many farms.

It remains to be determined how vulnerable livestock operations with less than 200 head are to climatic variability. If cattle are not a primary source of income, vulnerability may be buffered by other economic activities. If cattle do constitute a primary source of income, however, small operations may be the most vulnerable to drought. They may not have the means to improve water sources, practice rotational grazing, purchase supplemental feed, or reduce their herds when natural forage is in short supply. In these cases, a severe climatic event may have very negative impacts on the livelihood of the ranch operators and force them to sell out.

The available census data for southeastern Arizona indicates that the ranches in this region are representative of the state ranching profile. From the last national agricultural census, Cochise, Pima and Santa Cruz counties accounted for approximately 17% of the state s cattle inventory (AASS 1998). Cochise County, along with Maricopa, Pinal and Yuma counties, has been the major livestock producer of the state since the 1970s. Although Maricopa and Pinal counties still house the largest number of cattle, Cochise County has assumed a greater proportion of the state s inventory since 1970 (increasing from 5.4% in 1970 to 9.5% in 1997) and now supports an inventory of around 76,000 head (AASS 1998).

According to the 1992 USDA census, 68% of Cochise County s inventory is held in farms with over 200 head of cattle, while the largest number of producers are very small-scale, with less than 50 head of cattle (Figure 3). Similar to statistics at the state level, only 17% (92 farms) of Cochise County farms had herds of 200 head or more in 1992. This suggests that approximately 1/5 of the county s ranchers might be considered commercial in terms of our definition of a commercial herd size. Far more farms might fall into the commercial farm category if we used a definition of household income from livestock. Income data for Cochise County are not, however, available to us.

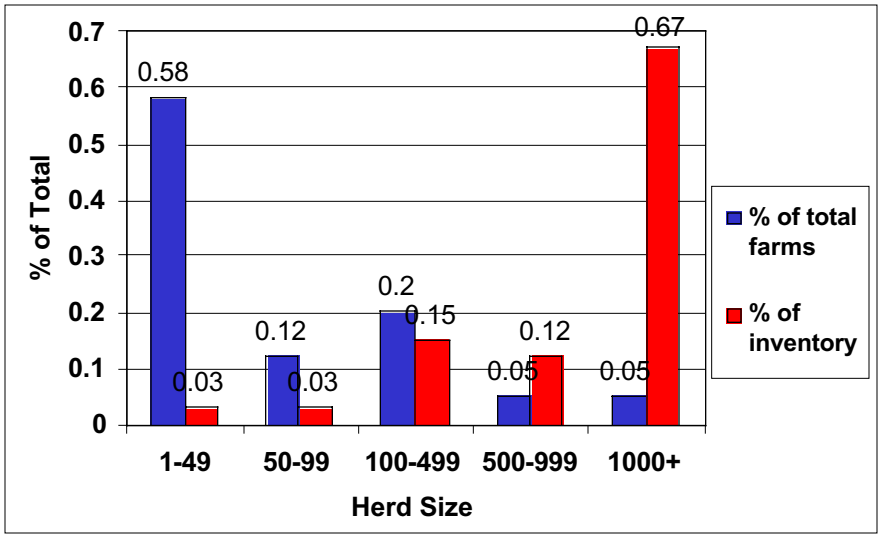
Selected Livestock Producing Counties in Arizona, 1997

County	Cattle Inventory	Cash Receipts from Livestock$1000	% of State Total Livestock Value
Maricopa	180,000	365746	41.2
Pinal	165,000	133326	15.0
Yuma	103,000	77672	8.7
Cochise	75,000	53003	6.0
Pima	40,000	29,529	3.3
Santa Cruz	17,000	10,600	1.2

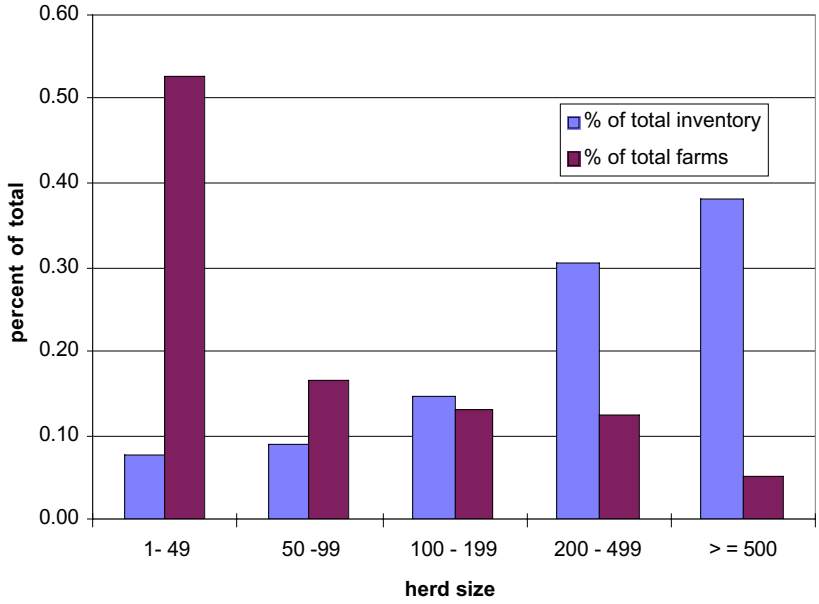
Source: Arizona Agricultural Statistics Service, 1998

This concurs with the University of Arizona Cooperative Extension Service report that the average herd size on *commercial* Cochise County ranches is 225-250 head. This number would undoubtedly be lower if non-commercial operations were considered.

Figure 2. Arizona Cattle Operations by Herd Size (USDA 1992)



Cochise County Cow/Calf Inventory and Operations by Herd Size (USDA 1992)



Type of Operations

Most ranches in Arizona are cow/calf operations, meaning that they maintain a herd of breeding females, a few bulls, and produce calves to be sold each year to feed lots for beef production. Stocker operations that run steers on rangeland for several months of the year before marketing the steers are also classified as beef operations by the state. In 1997, the state statistic service reported that 61% of the state s cattle operations (defined as any operation with one or more head of cattle) were beef operations (AASS 1998) (Figure 3). In Cochise County, the vast majority of livestock operations were cow/calf operations. In 1997, there was only one dairy ranch, and no steer operations (U of A Cooperative Extension 1997).

Cow/calf operations are particularly sensitive to interannual climatic variability in that the cycle of production in this type of operation spans several seasons. Inadequate range conditions during pregnancy can affect the health of the heifer, which in turn can diminish the calf crop not only during the immediate calving season, but also that of the subsequent year. The health of a calf is affected not only by the health of the mother cow, but by the range conditions in the first 6 months of its development. Weak calves will not only do poorly in the market, but will make poor replacement heifers for the herd. In this way, climatic conditions and the related response of the range can have a long-lasting impact on calf/cattle operations.

In contrast, steer operations are typically more opportunistic and have more flexibility in responding to year to year variations in range conditions. In years of high range productivity, steer operators may purchase several hundred head to run for several months on temporarily leased land and sell the fattened steer at a profit at the end of the season. When range conditions are poor, few steer operators will enter the market in Arizona.

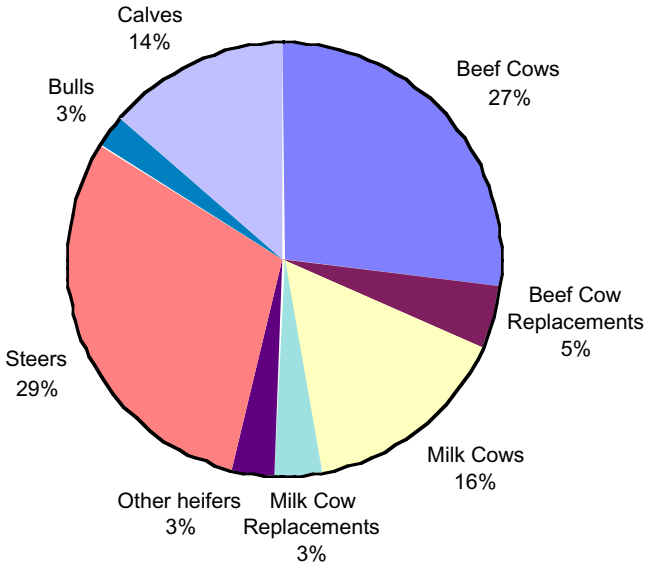
Livestock revenue

In Arizona, livestock products equaled about 41.4% of the total value of state agricultural products sold in 1997 (AASS 1998). Cochise, Maricopa, Yuma, Navajo and Pinal counties are the principal livestock producers in terms of value, accounting for 78% of the state s total marketed value of livestock products (Arizona Agricultural Statistics Service, 1998) (See table 1 above). Although the total value of livestock products sold in Arizona has increased since 1970, the sector is declining in relation to crop production as Arizona s agriculture diversifies (Figure 4). While cropland in Arizona is still largely concentrated in the production of cotton and hay, the area devoted to vegetable production has increased by 34,000 acres and is reflected in state revenues (Figure 5).

Approximately 85% of the land in farms in Arizona is classified as rangeland (Figure 6). Regardless of the importance of crop production to Arizona, livestock production remains the dominant form of land-use. A significant feature of ranching in the southwestern states is a dependence on leased federal and state lands. Approximately 80% of Arizona s land surface is publicly owned, and the USFS, BLM, and ASLD administer 28.6 million acres that are grazed by livestock. This is particularly significant to this study because of the potential consequences any change in land use and administration

could have on the state s economy and ecology, and thus on the vulnerability of the state to future climatic variability and change. As more land in Arizona is converted from range use to urban, suburban or industrial use, larger and denser populations generate a much greater demand for both groundwater and surface water. Wildlife corridors are broken, open spaces are fragmented, and recreational usage on public landscould have on the

Figure 3. 1997 Arizona Cattle Inventory by Cattle Type



Note: The relatively high percentage of steers may reflect steers in feed lots as well as on the range.

state s economy and ecology, and thus on the vulnerability of the state to future climatic variability and change. As more land in Arizona is converted from range use to urban, suburban or industrial use, larger and denser populations generate a much greater demand for both groundwater and surface water. Wildlife corridors are broken, open spaces are fragmented, and recreational usage on public lands skyrockets. In some areas, increasing urban demand for water is more than offset by the retirement of irrigated farmland because agriculture still consumes about 80% of the state's water. Nonetheless, the vulnerability of Arizona society as a whole to climatic variability increases as aquifers are overdrawn and surface water reservoirs are stretched thin.

In our study area, state administered land is particularly important to ranchers. Approximately 42% of Cochise County s grazed rangeland is administered by the ASLD, 33% is in private hands, 15% is controlled by the U.S. Forest Service, and 9% by the Bureau of Land Management. The amount of private deeded land under grazing use and the role of the ASLD in grazing leases is different from many other areas of the state

where typically the Bureau of Land Management is the primary land administrating agency. Although we have not yet been able to determine what ranchers have access to what combination of public and private land, we know that in Cochise County, state and private land play important roles in grazing strategies. This understanding is what justified our use of Arizona State Land Department leasee files in selecting ranchers for our initial pilot interviews in Benson, Arizona in February of 1999.

Figure 4. Contribution of Livestock and Crops to Market Value of All Agricultural Products Sold, 1968-1992 (USDA Agricultural Censes)

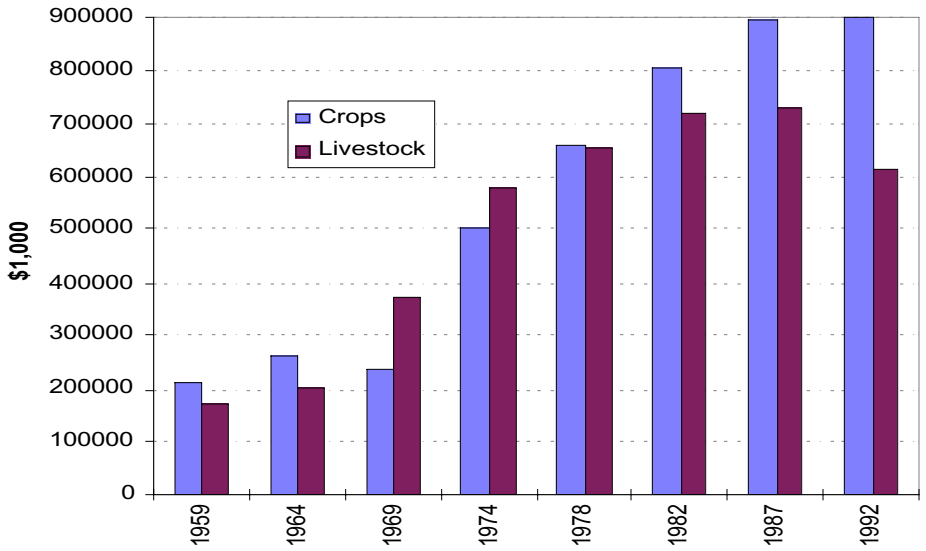


Figure 5. Arizona Agricultural Products as a Percentage of State Cash Receipts for Agriculture (Arizona Agricultural Statistics 1997)

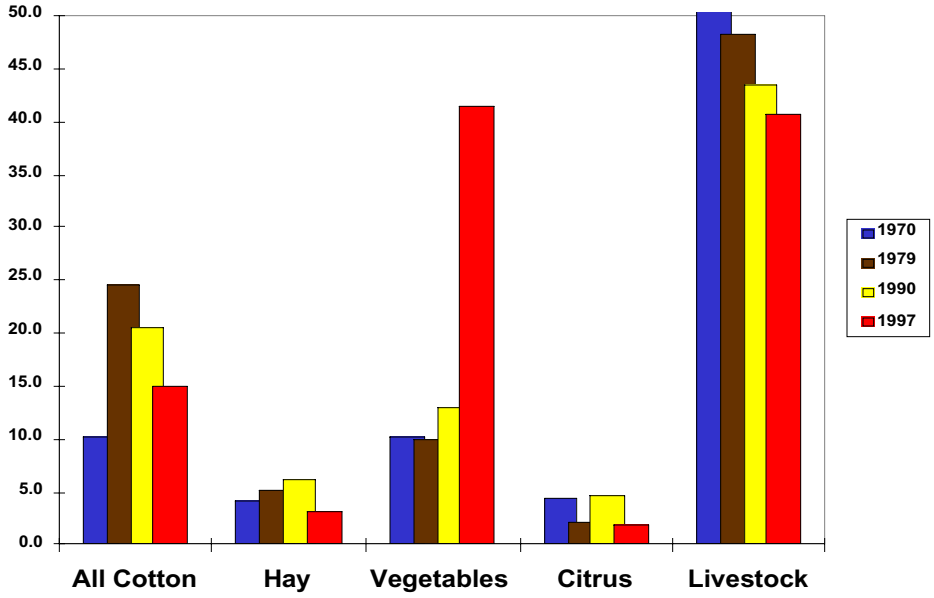
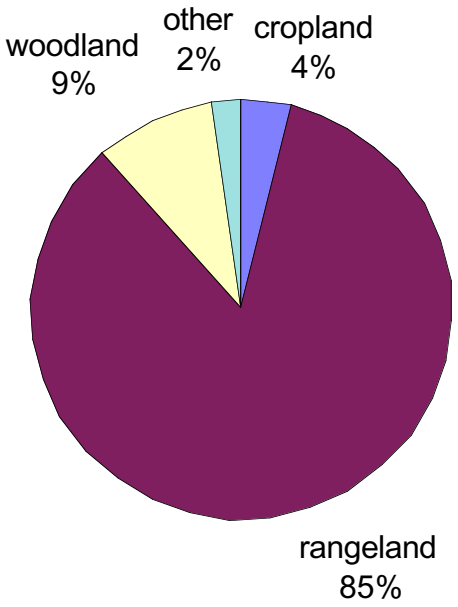


Figure 6. Classification of Farmland in Arizona (USDA 1992)



Because we are considering land management factors and land use regulations as one source of uncertainty for area ranchers, differences in land management policy between agencies can influence how ranchers perceive the uncertainty of their tenure. We hypothesized that recent changes in state land lease regulations would be a concern for Cochise County ranchers, given the importance of state land in that county. In this case, Cochise County ranchers vulnerability may be different than other ranchers in the state who rely more on federal allotments. The Forest Service is known among ranchers for its imposition of conservative stocking rates. Ranchers are often required to cut back their herds in drought years. Different agencies have different agendas, different constituencies, and different agency cultures. Ranchers must deal with these political realities as well as with a variable climate.

Land Ownership and Administration (as % of Total Land Area)

County	U.S. F.S.	BLM	ASLD	Indian	Private	Other
Cochise	12	9	35	0	41	3
Grazing*	*15*	*9*	*42*	*0*	*33*	*1*
Santa Cruz	53	< .5	8	0	39	0
Pima	7	6	15	42	11	19
State	15	20	13	28	16	8

* percent of total **grazed** land by administering agency

III. Factors Contributing to Vulnerability

Physical Impacts of Drought

Drought periods directly affect range productivity and thus grazing capacity. Drought has been known to reduce forage production by more than 50% (Holecheck 1998:355). In addition during drought the vigor of remaining plants is reduced and can result in plant mortality. In extreme disturbances the more palatable perennial grasses can be replaced by less palatable forbs (Holecheck 1998:155). The seasonal distribution of rainfall and the temperature when soil moisture is available can favor certain life forms over others. A winter drought followed by summer rain may be beneficial to warm season, perennial grasses, while a summer drought followed by winter rains would favor winter annuals, shrubs, and halfshrubs (Burgess 1995:42).

The ranchers interviewed in our study reported that as a result of poor forage conditions in the 1996/97 and the 1998/99 year, calf crops and weaning weights were lower than normal. In some areas the range, didn t grow a weed or a blade of grass. Another noted that transects used for monitoring of vegetation in the fall of 1998 could not be read because the plants were indistinguishable. Coupled with poor forage conditions was a general scarcity of water for cattle. For a pasture to be available for grazing, it not only has to have sufficient nutritious vegetation, but also it must have adequate water supplies. Some ranchers rely on well water, but often ranchers use dirt tanks to capture summer monsoon rainfall and use this water for their cattle over the winter. During the recent droughts, these dirt tanks dried prematurely, making many pastures useless for cattle even though forage was still available.

Coping Strategies

Land Use. In Arizona, drought can be a function of both spatial and temporal variability in rainfall. Because of the complex topography of the state, precipitation is typically more abundant on mountain slopes and in upland areas. Rainfall in the desert valley is far more unreliable and spatially dispersed. Several ranchers we interviewed complained that their experience with drought had been significantly different from their neighbors as a result of this variability.

Managing this variability is challenging. Proper range stocking involves the balancing of forage demand with the forage resource. Stocking rates in Arizona reflect the low level of productivity of the arid environment. In the Desert Grassland of Arizona approximately 60 acres of good condition range are required to support one 1000 lb cow, a figure which greatly exceeds that of other regions of the country where rainfall is more reliable and plentiful (Martin and Ward 1976). A ranch may encompass diverse ecological conditions and terrain, a fact that in some cases can improve the flexibility of a rancher in responding to climatic stresses, and in other cases can prove to be an obstacle to effective administration and management.

Most of the ranchers we interviewed had a specific grazing strategy that involved several pastures used at different times of the year and in some cases different years as certain pastures were rested. Only one rancher said, my cattle do their own rotation. Several ranchers had spatially dispersed land: pastures in both Benson and Sierra Vista, or

Three Points and Sonoita for example. This also enhanced their flexibility, enabling them to move their cattle from one area to the other in response to variable conditions. This, however, is a short-term strategy. Almost all the ranchers we interviewed said that although the rainfall was highly variable across their pastures, they could not rely on one particular area to carry them through a prolonged drought. Eventually, all areas are affected in some way.

The spatial variability in the rainfall patterns also meant that ranchers could try to sub-lease pasture locally to augment the forage available to their cattle. This is an expensive strategy, but one that many ranchers in the Benson area seemed to have used in the 1990s to cope with poor range conditions on the land they lease.

Water management. Even if a rancher has managed to find some land on which forage conditions are adequate, unless that land has a reliable source of water, it is almost useless. In the most recent drought period (1998/99), all the ranchers we interviewed in Cochise County had been severely affected by water shortages. All the ranchers had dirt tanks on their properties, designed to capture the summer rainfall and provide water for the winter pastures. In addition, some ranchers had several wells on their leased and deeded land from which they could pump water. At the time of our interviews in February 1999, almost all the ranchers we spoke with reported that their dirt tanks were dry and had been so for several weeks. Because these ranchers rely on these tanks to provide water for at least part of the year, this was a crisis situation for these ranchers.

The ways ranchers coped with the problem depended on how long they had been struggling with the water shortage. One respondent reported spending 5-7 hours per day and $1500 per month in 1997 to haul water to areas where wells and tanks had dried. Another respondent reported hauling water for the last five years, noting that the expense of doing so runs up the price of the beef. This same respondent had several wells he was relying on that as yet were not affected by the drought. He remembered that these same wells had dried up in the past — during a drought from 1941-47, illustrating that even the well water, in severe situations, could be affected.

Some ranchers who had decided that their pastures were too vulnerable to water shortages had applied for government assistance (through the EQUIP program) to put in more water infrastructure on their property. These ranchers hoped that larger stock tanks (as large as 50,000 gallons), pipelines and wells would increase their accessibility to water should the dry years continue. For example, one Benson-area rancher reported that during a drought in 1981 she had had to drastically cut back her herd because of a combination of poor range conditions and water scarcity. She then arranged to put in a permanent deep well with support from the Soil Conservation Service and she feels this well has dramatically changed her operation in drought years. Although some of the shallower wells went dry in the 1998/99 year, the deep well has continued to function.

In these cases, it appears that one of the ways ranchers are managing prolonged droughts is to reduce their reliance on rainfall, and increase their dependence on ground water resources. The sustainability of this strategy for the county at large and for Arizona is questionable. These ranchers do not pay for the water pumped; they pay only for the infrastructure (often with government support) and the electricity costs of pumping. This does not mean, however, that water is cheap. One rancher reported spending $10/day on pumping; another said he had been spending $1500/month. An

increased reliance on groundwater resources might increase community water conflict in the future, particularly in areas of rapid urban expansion (such as Benson) or where fragile wetland ecosystems are threatened.

Supplemental feed. All the range managers from the BLM, ASLD, or USFS actively discourage or prohibit ranchers from providing their cattle with supplemental forage on leased allotments because they believe supplemental forage only encourages overstocking. Small amounts of nutritional supplements (such as salt licks) are permitted, but range managers usually specify where these supplements can be placed in order to avoid trampling around water sources and other areas of heavy use. Ranchers of course are free to feed their cattle on their deeded lands, and several ranchers in the Benson area reported resorting to supplemental feed in the last 5 years as a result of poor range conditions. All said the acquired their feed and supplements locally — hay, mineral blocks, and salt. One rancher said that he had purchased hay until it became too expensive; at $250- $300/ton, he could not afford it. Another rancher estimated that providing supplemental feed for his herd (around 150 head) would cost him $10,000 a year. This rancher remembered paying $3000 for hay alone in 1997.

Destocking. As a last resort, ranchers will cut back on their herd size, beginning with older cows and moving, if necessary to their prime breeding herd. Again, all ranchers in Benson had resorted to this strategy in response to recent drought conditions. One rancher cut his herd in half after drought conditions in 1992 and has not yet been able to restock. Another reported selling off 10% of her herd in 1998 in response to poor conditions. During the 1996 drought year, the ranchers interviewed reported destocking anywhere between 10% to 50% of their herds. Ranchers who are forced to sell off a large percentage of their herd are cutting deep into their assets and do not recover easily from the drought s impact.

Destocking is sometimes requested by the public agencies from whom ranchers lease land. The Forest Service is known for its stricter controls on stocking rates during drought periods. Forest Service allotments were more common among the ranchers interviewed in Maricopa, Pinal and Pima counties in 1997, and thus the regulations of this agency played a larger role in culling decisions. Lack of human resources inhibits the other agencies from undertaking as intensive monitoring of properties and enforcement of stocking rates. For this reason agency policies on stocking rates were not featured in our discussions with ranchers in Cochise County this past season.

Other coping strategies. Aside from the actions discussed above, ranchers may have the opportunity to seek financial support from credit institutions or from federal agencies under emergency programs. Almost all the ranchers we spoke with were extremely negative about resorting to loans to carry them through a drought period. Debt was viewed as a sure way to increase vulnerability to both weather and market fluctuations. Other than the more routine support ranchers acquired for pasture improvements, few ranchers said that they had taken advantage of feed cost-sharing programs instituted by the federal government in past drought years. The general attitude of the ranchers we interviewed was that the government was not particularly supportive or concerned about the plight of ranchers in the Southwest.

Market Factors Contributing to Vulnerability

Our pilot interviews confirmed that vulnerability was not simply a function of diminished rainfall, but rather the combined effect of poor pasture conditions, rock-bottom cattle prices, and soaring feed prices. Ranchers interviewed in 1996 reported price declines of 30-50 percent from previous years. This meant that income from cattle sales was effectively cut in half for many ranchers while overhead costs remained the same or increased. Cattle prices in 1996 initially reflected the fact that the industry was at a cyclical peak in inventory, and then perhaps prices were exacerbated by environmental and economic conditions in Mexico and the southwest. In 1996, a number of ranchers believed that the North American Free Trade Agreement was partially responsible for the low cattle prices ranchers faced in the cattle markets. At that time, survey respondents spoke of the flood of Mexican cattle into the US as a result of a relaxation of import restrictions on Mexican cattle. The drought of 1996 was occurring simultaneously in northern Mexico so that ranchers in this region were also struggling to cope with adverse conditions. A more open market with the United States may well have represented an opportunity to quickly reduce herds as forage conditions deteriorated. Unfortunately, we have not yet been able to locate data on the number of Mexican cattle that entered Arizona s cattle auctions during the drought periods we are studying.

Although we have not finished our assessment of ranchers responses to the 1998/99 drought, our pilot interviews reflected similar concerns with market conditions. One rancher reported the laundering of Australian cattle through Mexico in 1998-99 as one phenomenon that was affecting local market conditions. According to ranchers in 1999, cattle prices had improved slightly, but were still of concern.

Grain and hay prices in 1996 were also their highest in many years. Increased demand for corn-derived industrial products and grain to feed burgeoning cattle inventories in China, along with poor grain harvests in Argentina and other parts of the world constrained supplies. Although expenditure on feed increased from a low in 1992-93 (a year of heaving rainfall and floods in some parts of the state), for many operations supplemental feeding became cost-prohibitive and supplemental feeding as a coping strategy was impossible (Figure 7). Even those receiving government assistance found their resources strained. One rancher had to purchase 50% more feed than normal to survive the 1996 drought.

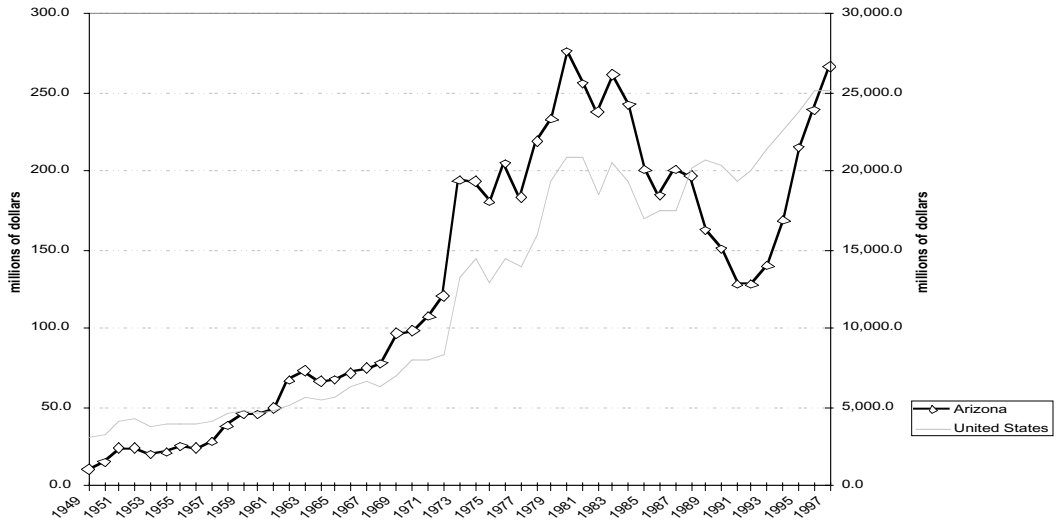
Political Factors Contributing to Vulnerability

Though more difficult to substantiate many of the ranchers surveyed perceived increasing federal regulation brought on by pressure from environmental groups as a serious threat to their operations. Our conversations with ranchers were often dominated by their frustration and concern over the viability of their operations in face of environmental policy changes.

A full third of Arizona ranches include a combination of two or more agency-administered grazing allotments, of BLM, Forest Service and/or state land (Ruyle 1991:84). The patchwork nature of tenure arrangements means that ranchers must answer to several agencies at once, each with its own procedures and requirements. As was the case with several ranchers we interviewed, drought conditions can bring on de-

stocking requirements. Each agency has a different system for implementing temporary removal of livestock. Because of the amount of land in Arizona under public administration, most ranches would not be viable without access to forage resources on public lands. Deeded land is often isolated and surrounded by agency allotments. Consequently, the loss of access to these allotments can jeopardize the ability of the ranch to operate efficiently, and constrain the flexibility of ranchers in times of drought stress. Given the land-extensive nature of these operations, loss or significant reduction in grazing leases could have serious implications for the pace and direction of land use change in Arizona.

Figure 7. Expenditures on Feed for Arizona and the United States, 1949-97 (Economic Research Service)



Recent attempts to put state land grazing leases up for competitive bidding and to lease BLM grazing lands for conservation purposes have heightened rancher concerns regarding security of tenure. State trust land must, by law, be leased for the activity that can bring in the highest revenue to the state. Ranchers fear that this change will enable entrepreneurs and environmental groups to outbid them for access to grazing land. Public land agencies have also been increasingly under fire from environmental groups, some whose clear objectives are to end ranching on public land. Ranchers fear that implementation of the Endangered Species Act may mean a loss of access to public ranching allotments they have relied on for decades. Riparian areas may be excluded, seasons of use regulated, and complex monitoring requirements imposed, particularly if the area is believed to be habitat for a threatened or endangered species. Whether the threat is real or perceived, ranchers view environmental policy as a major source of uncertainty and anxiety in their operations.

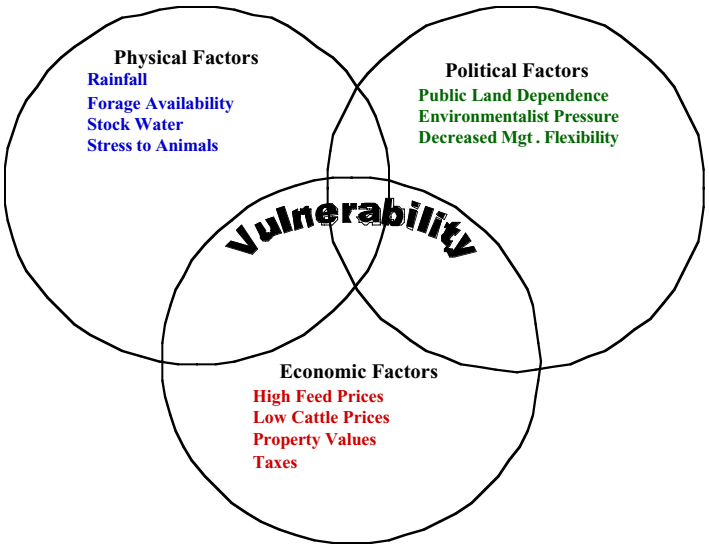
Real Estate Factors Contributing to Vulnerability

Finally, Arizona is one of the most rapidly growing states in the nation, experiencing a 15.1% growth rate between 1990 and 1995. Many of the newcomers are retirees or professionals who seek scenery and recreation opportunities. The demand for ranchette properties and suburban expansion have put land prices at a premium, increasing property taxes and inheritance taxes at a time when many older ranches are about to change generational hands. During a drought, the chance to sell off parts of a ranch s deeded land becomes more attractive to ranchers. As one rancher put it, If someone comes up to you and says I want 5 acres and hands you $250,000 you re going to say, SOLD! . Over half of the ranchers interviewed had been approached to sell their deeded land and several had already considered the idea given the current challenges faced by the livestock industry.

Combined Factors Rendering Ranchers Vulnerable to Interannual Climate Variability

No single factor alone is likely to put a rancher out of business, but when cattle prices, the government and public sentiment align themselves in a drought year or two, ranchers are more likely to go out of business (Figure 6). Our interviews suggest that smaller operations, those with less than 200 head, are most likely to be eliminated during hard

Figure 6. Factors Combining to Create Vulnerability to Climate Variability



times because of their lack of financial capital to buffer stresses on their operations. Those who remain will be the ones who make wise management decisions. The decisions will likely involve advanced planning and include any number of the following strategies:

1) Reduction of livestock in accordance with forage availability rather than supplemental feeding.
2) Conservative stocking before, during and after drought.
3) Confinement of cows in spring(with short-term supplemental feeding) and early weaning of calves if feed prices allow.

The best tools for dealing with drought are advanced planning and flexibility (Holecheck 1998:353).

Climate Information Needs and Rancher Perspectives on Climate Forecasting

In order to understand where climate information fits into a rancher s decision-making, we tried in our interviews and questionnaire to outline a rough schedule of activities and decisions made by ranchers during any given year. One of the first differences we noted between the ranchers we interviewed in 1997 and those interviewed in the Benson area in 1999 was that the marginal Benson ranchers did not seem to have a regular schedule of activities they followed. These ranchers bred cattle year-round, and thus sold calves year-round. They lacked the resources to fence-in their pastures and thus did not follow a particular rotation schedule. Nor were they producing a large enough calf crop in any one month to organize a private sale to a set buyer. In contrast, the ranchers we interviewed in 1997 were generally larger, more organized operations. With the help of fenced pastures, these ranchers typically controlled the timing of their cattle breeding, and thus the timing of the arrival of their calf crop. Most of these ranchers sold their calves twice a year at set times, and sometimes to particular buyers.

We hypothesized in this study that climate forecasts will be of most assistance to ranchers who undertake advance planning in their operations. These ranchers may be able to gain from reliable forecasts by adjusting their timing of cattle breeding, cattle sales, pasture rotation or budgets for ranching inputs such as supplemental feed. More forward-looking decisions, such as investments in range improvements, purchases of bulls or farm equipment, or applications for new allotments might also benefit from knowledge of climatic trends.

Although we still need more data, our pilot interviews in Benson indicated that for smaller ranchers (100-200 head, family operated, minimal resources), climate forecasts may have little use. Not only were these ranchers extremely skeptical about the reliability of the information), but they also had a difficult time imagining how they would be able to use a forecast. As one rancher put it: I d have more interest in some authentic Indian rain dances. It would be the same thing! I think somebody s barking up the wrong tree. Most of their decisions are made on the basis of weekly observations of cattle

prices and market conditions, the weight of their cattle and the condition of their range. Knowing that poor climatic conditions would continue for some time, or that rain might arrive in the next weeks could influence their decision to sell a calf or cow. Because these ranchers do not have the capital to undertake large investments, knowing that dry conditions would continue into another year of their operation might not make much difference. One rancher thought that this information would make him hesitate to invest in a new truck, for example, but that otherwise he probably wouldn t change his procedures much. A forecast would either add gloom to a difficult situation, or provide hope that the ranch would be able to survive one more year. The wait and see approach was the most prevalent in these rancher s decisions.

The Benson-area ranchers were on the whole far more interested in receiving information on climatic trends and patterns rather than forecasts. One rancher was convinced that his ranch experienced 10-year drought cycles and wanted to see how the data might reflect this perception. Others were interested in knowing whether there had been a drying trend in their region, or how the current drought compared to past extreme events. Ranchers were not only interested in recent climate history, but also the tree-ring data that provides a longer time-frame of climatic variability. Such historical information might include precipitation trends, temperature trends, vegetation trends and drought cycles and patterns. To assist ranchers in making sound management decisions, information that shows linkages between vegetation growth and precipitation variability, particularly any information that shows the relative importance of summer and winter rainfall to local range conditions and water supplies, might be particularly useful. Ranchers in the Benson area feel that summer rainfall is more critical to their range vegetation than rainfall at other times in the year.

In general, these ranchers lacked appropriate biophysical contextual information that would enable them to grasp the significance of climate variability in their operations. While they feel they know their own ranch well, they wanted to see how the climatic variability on their ranch related to other areas spatially, and how the variability had changed temporally. Several ranchers also mentioned that they would appreciate forecasts in other areas in the country — the Midwest, for example — that were either cattle producing regions or regions where most of the feed lots were located. They understood the relation between climatic events and grain prices, calf demand and cattle prices and thought that having forecasts in hand would help them in their planning. These ranchers generally agreed that such information, while not necessary for any particular decision, would be helpful in understanding the biophysical constraints on their operation, and the implications of their management decisions on the environment.

In contrast, more of the operators we interviewed in 1997 thought that long-range climate forecasts would be useful if they could be proven reliable (e.g., between 50-80% reliable) and if they had sufficient spatial specificity. These ranchers were particularly interested in how the forecasts might change their decisions on the timing of cattle sales and purchases. Avoiding the gluts in the cattle market that commonly occur during drought periods could represent a significant advantage for ranchers who wanted to sell their herd when cattle prices were still relatively high. This would mitigate one of the more severe impacts of drought: the regional depression of cattle prices that occurs when large numbers of ranchers cull their herds simultaneously. For ranchers who typically do

some culling in the spring, a forecast of the summer monsoon would be particularly helpful. If summer rainfall was anticipated to be poor, these ranchers might decide to destock more heavily in the spring before the range deteriorates. On the other hand, a forecast of a good monsoon season after a poor winter rainfall season might prevent ranchers from selling off their herd prematurely.

It was obvious to the research team that one of the most important sources of decision-making information that ranchers regularly rely on is market data. Most ranchers, regardless of resources and scale, keep track of local and regional cattle prices. For the regional information, they consult ranching periodicals such as *The Drover s Journal*, USDA livestock reports, *The Western Livestock Journal*, or *The Progressive Farmer*. For local price information, several ranchers get faxes or mailings from the local cattle auctions announcing sales and past trends in prices. Because ultimately cattle prices will have one of the more significant influences on rancher decisions (unless the ranch is in crisis, and the rancher has to sell regardless of price), incorporating climate information into these periodicals and reports could prove to be an effective way of improving the base of information on which ranchers make decisions.

Next Steps

The statistical profile of ranching in Arizona, and the number of interviews and surveys we now have completed provides an initial understanding of the multiple factors affecting the vulnerability of ranching in Arizona to climatic variability and the potential

Preliminary Climate Information Needs of Benson Ranchers

Information Needs	Timing	Scale	Application
historical precipitation	anytime	sub-state level (climate division)	contextual
historical vegetation (satellite record?)	anytime	sub-state, ideally ranch	contextual, range management
annual or seasonal forecasts of drought probability	spring / fall	sub-county	livestock sale, feed purchases, range management
seasonal forecasts for Midwestern states	anytime	regional	estimation of grain prices, feeder calf demand, calf prices
link between vegetation condition and rainfall	anytime	county level (region of homogeneous vegetation conditions)	range management

use of climate information in mitigating this vulnerability. In the next several months (June 1999 - Sept. 1999), additional data will be collected on ranchers in southeastern Arizona. We are now receiving replies from the first mailing of questionnaires to

ranchers in eastern Cochise County. With additional survey results from a distribution of questionnaires to several ranching organizations (the Cowbells and the Malpai Borderlands Group) in Cochise County, we feel that we will have a relatively good assessment of the vulnerability, coping strategies and interest in climate information of ranchers in this region.

This summer we also plan to continue with our statistical data analysis and development of a GIS. As mentioned above, there are numerous problems with the geo-spatial data and these need to be resolved before the project can make much use of the database. We plan to eventually expand this database to cover the whole state of Arizona. This will involve further collaboration with the University of Arizona s Center for Applied Spatial Analysis (CASA) and with the various public agencies that administer ranching leases in the state. This database will not only serve to provide contextual environmental, social and political information on the ranching sector, but will enable us to test our hypothesis of vulnerability through data queries, and to place the ranchers we interview in a spatial context.

In the fall of 1999, we hope to expand our research from the southeastern portion of the state to the central and western counties of Arizona. We will contact ranching organizations in these counties and then conduct interviews and focus groups with ranchers in these areas. We are collaborating with the physical scientists on the CLIMAS team to develop a powerpoint presentation that summarizes the purpose of CLIMAS and provides an introduction to the climate products and information available in Arizona. We think that this will be an effective way of stimulating interest in the project among the ranching community, while informing ranchers about climate information that is currently available and obtaining useful feedback about the types of information they find most useful for their operations and how they would like to receive this information. We hope to identify individual ranchers from these areas who will serve as informants and co-researchers, enabling us to collect information from a larger sample of ranchers than we have been able to do in the southern part of the state.

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